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Flow and Benthic Ecology 4D - FLOWBEC - An overview

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Flow & Benthic Ecology 4D (FLOWBEC)

Paul S. Bell & David McCann – National Oceanography Centre, Liverpool

Philippe Blondel - U.Bath

Angus Creech & David Ingram – U.Edinburgh

Dan Conley – U.Plymouth

Graham Savidge – Queens U. Belfast

Bob Kennedy, Jack O'Carroll National University of Ireland, Galway

Beth Scott, James Waggitt & Benjamin Williamson - U.Aberdeen

Lars Johanning & Ian Ashton – U. Exeter

Ricardo Torres & Pierre Cazenave – PML

Eric Armstrong & Chris Hall – Marine Scotland Science

Summary

Using developments in high resolution physical modelling and state of the art observation systems, we aim to identify the physical conditions influencing the behaviour of fish and their predators and also benthic communities by concurrently measuring hydrodynamics and biology at 3 different wet Marine Renewable Energy test sites.

Funding of £1.2M over 3 years – started September 2011

Progress:

- **Activities related to EMEC tide and wave sites**
- **Activities related to Wave Hub**
- **Activities related to Strangford Lough**

- **Application of FLOWBEC related techniques to commercial sites**



Activity at EMEC wave and tidal sites

At the surface:

- Marine Radar monitoring (currents, roughness, bird tracking)
- Bird Observations & linkages with measured and modelled hydrodynamics (James Waggitt's talk – combined work with RESPONSE)

Under water:

- 5 deployments of the FLOWBEC sonar frame (Benjamin Williamson's talk)

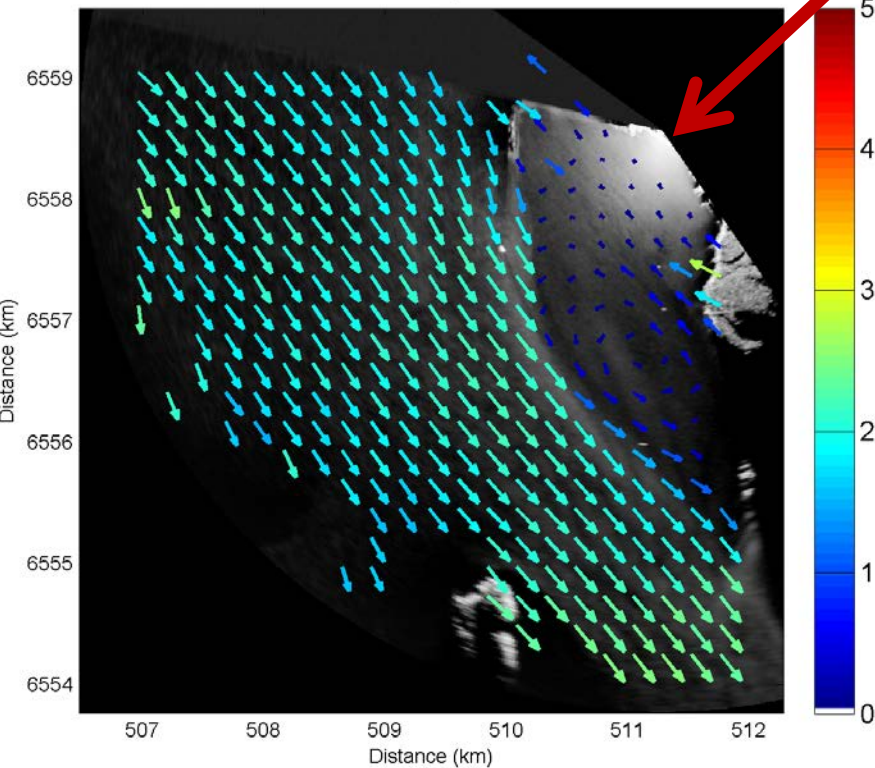


FVCOM modelling (PML)

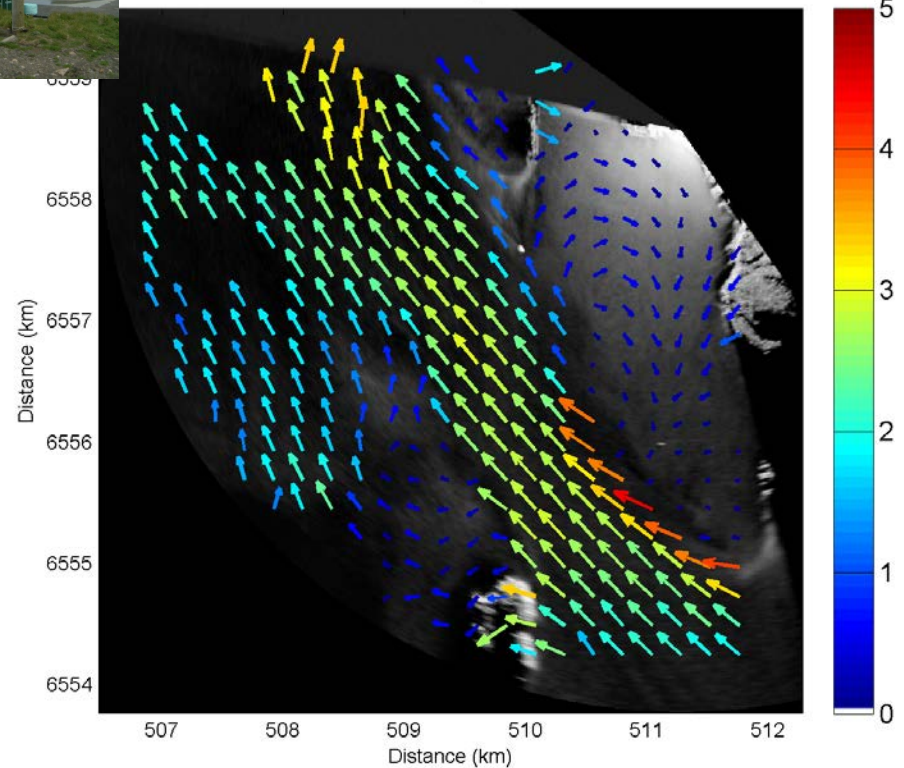
Radar Flood and Ebb Currents at EMEC tidal site



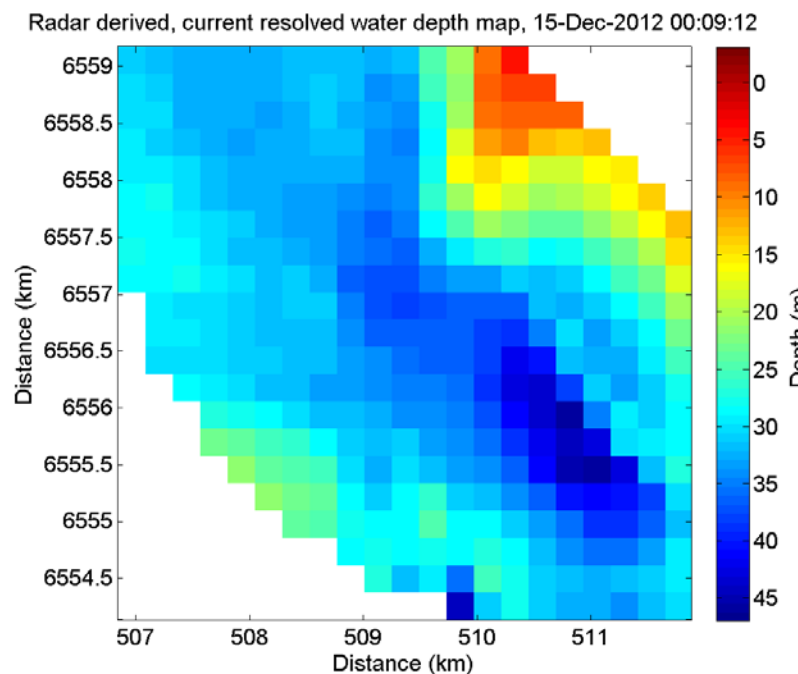
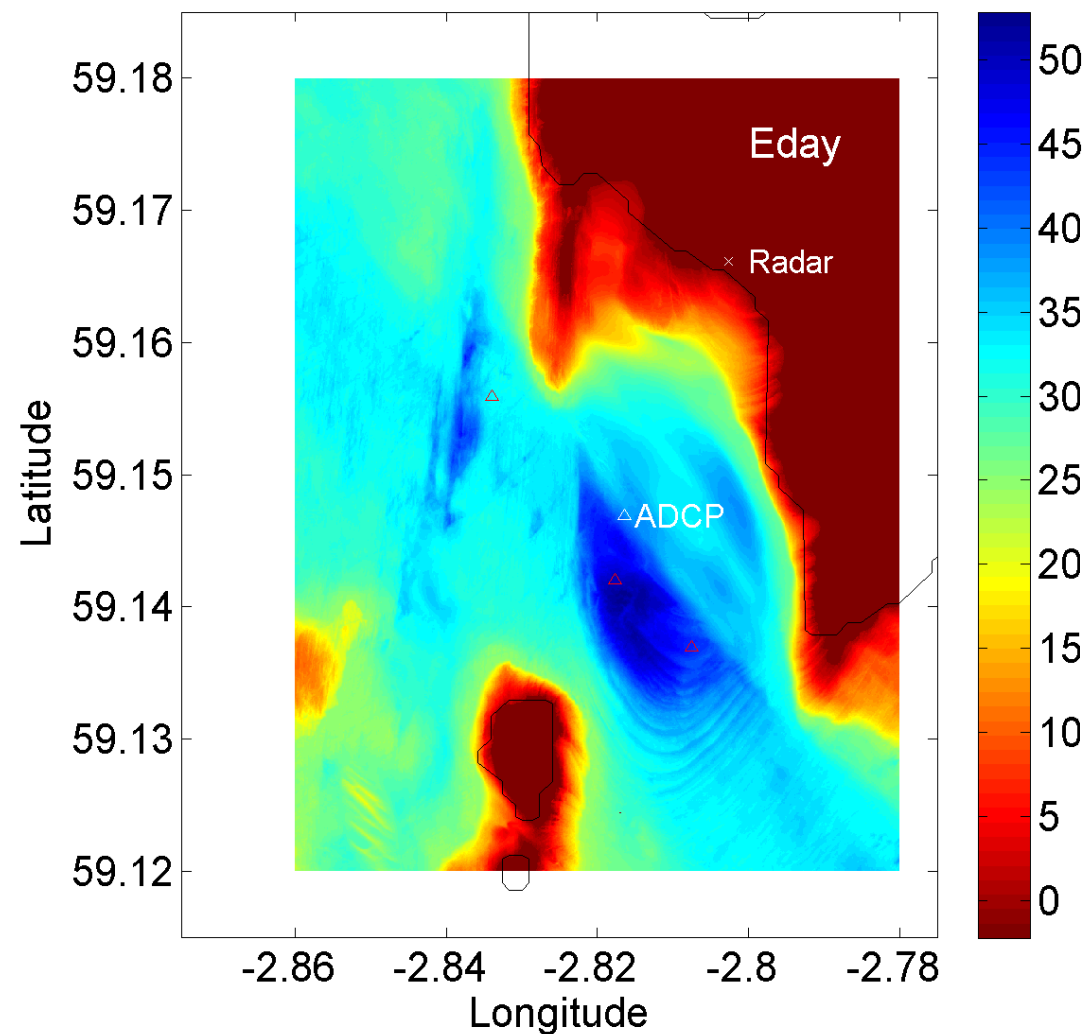
Radar derived current vectors, 20-Dec-2012 00:49:51



Radar derived current vectors, 20-Dec-2012 19:46:11

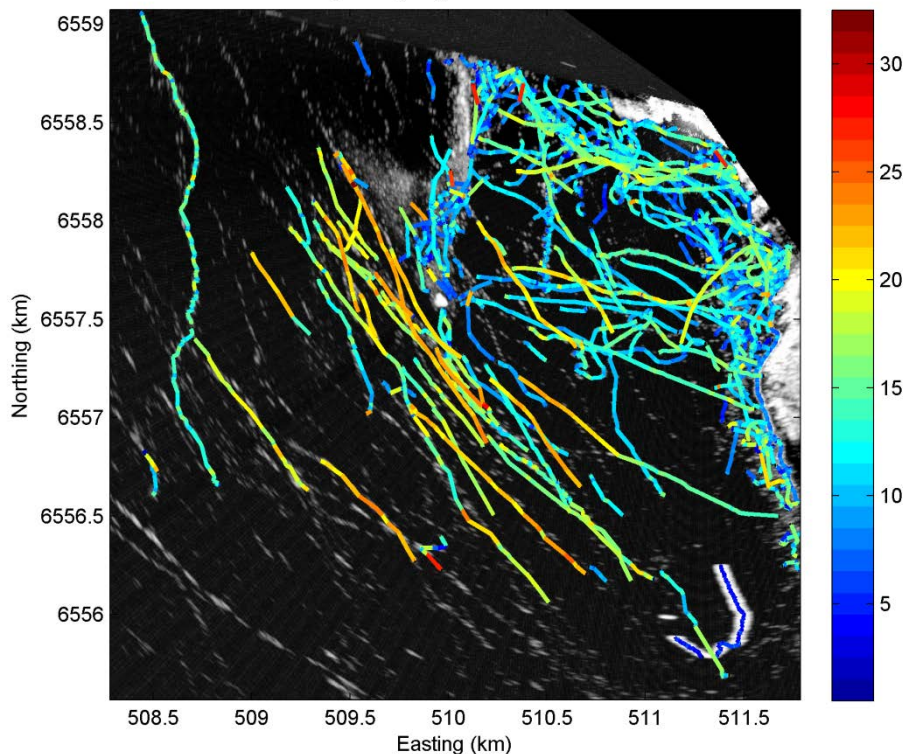


Survey & Radar derived bathymetry

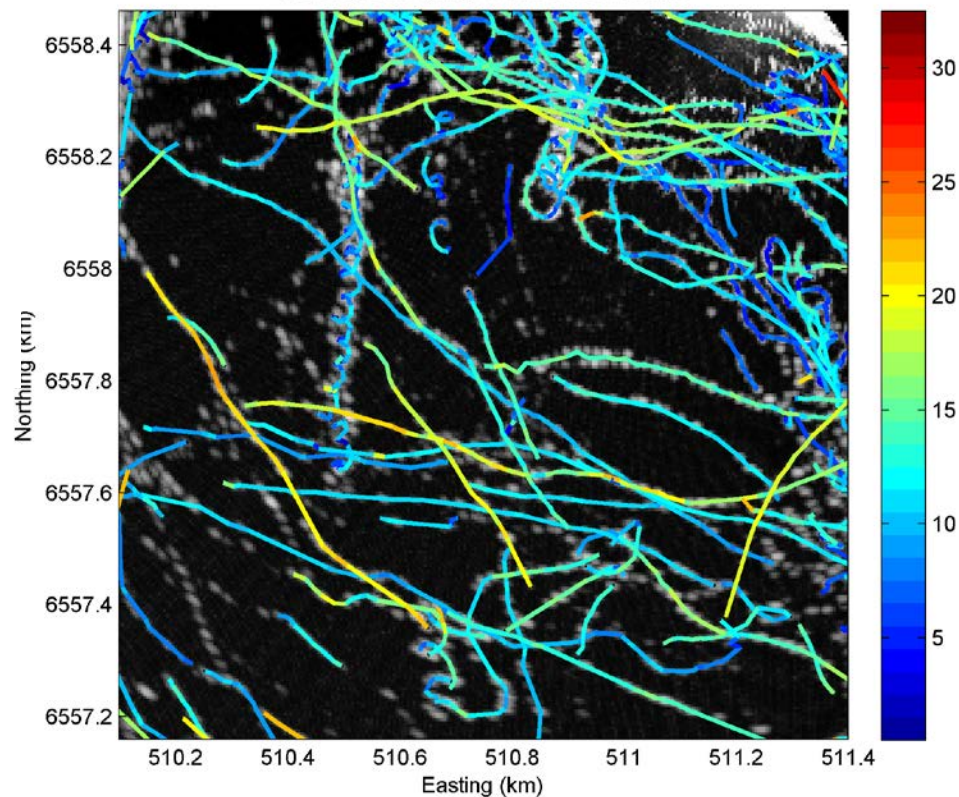


Small Target (Bird/Beastie) Tracking

Track speeds (m/s), 14/06/2012 11:00am

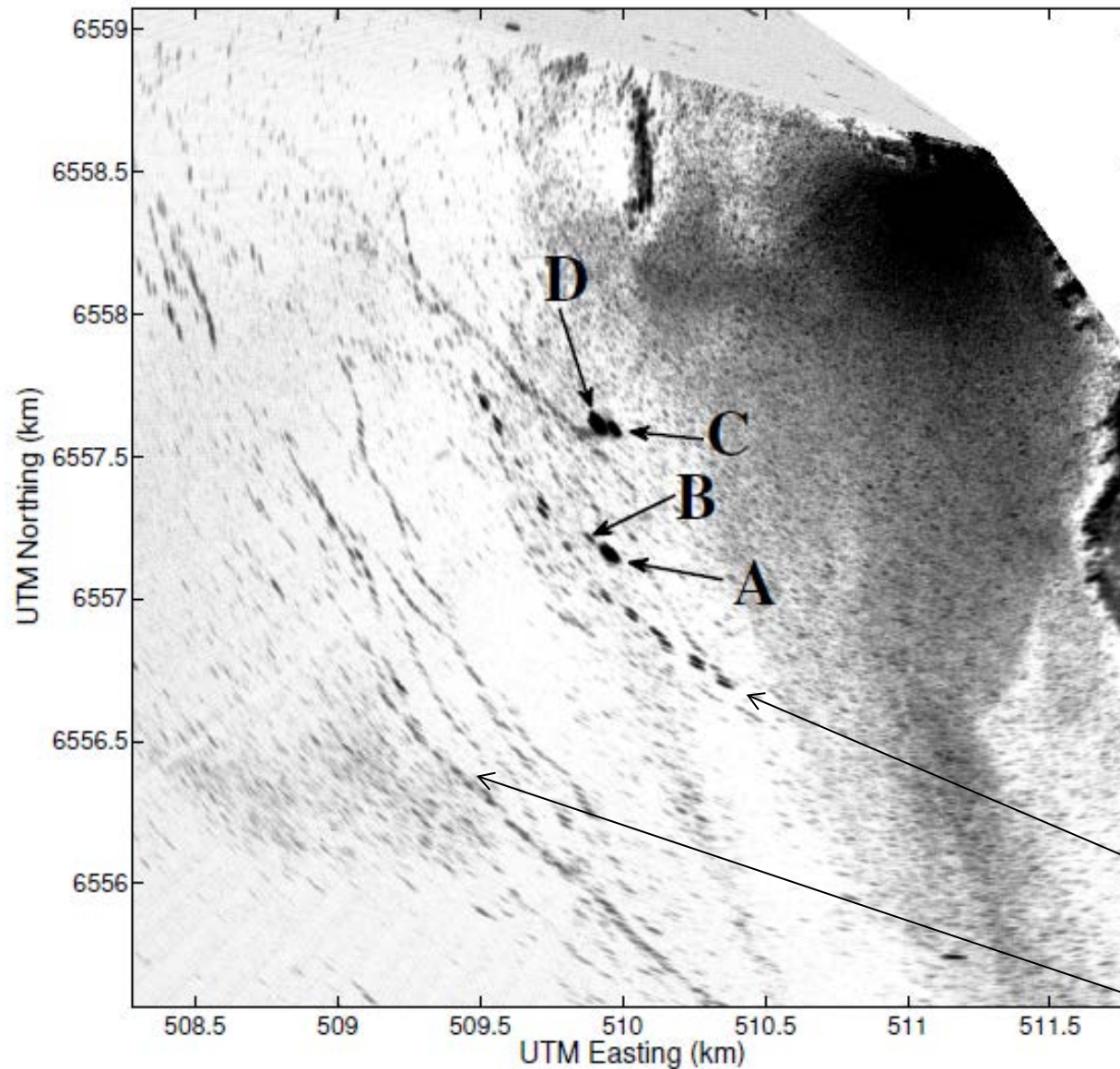


Track speeds (m/s), 14/06/2012 11:00am



Target tracks in a single five
minute radar record
colour = speed (m/s)
Images by David McCann (NOC)

Confirmed Orca Tracks (breaching) captured on radar June 18th 2013



A: FLOWBEC
frame deployment
vessel

B: support vessel

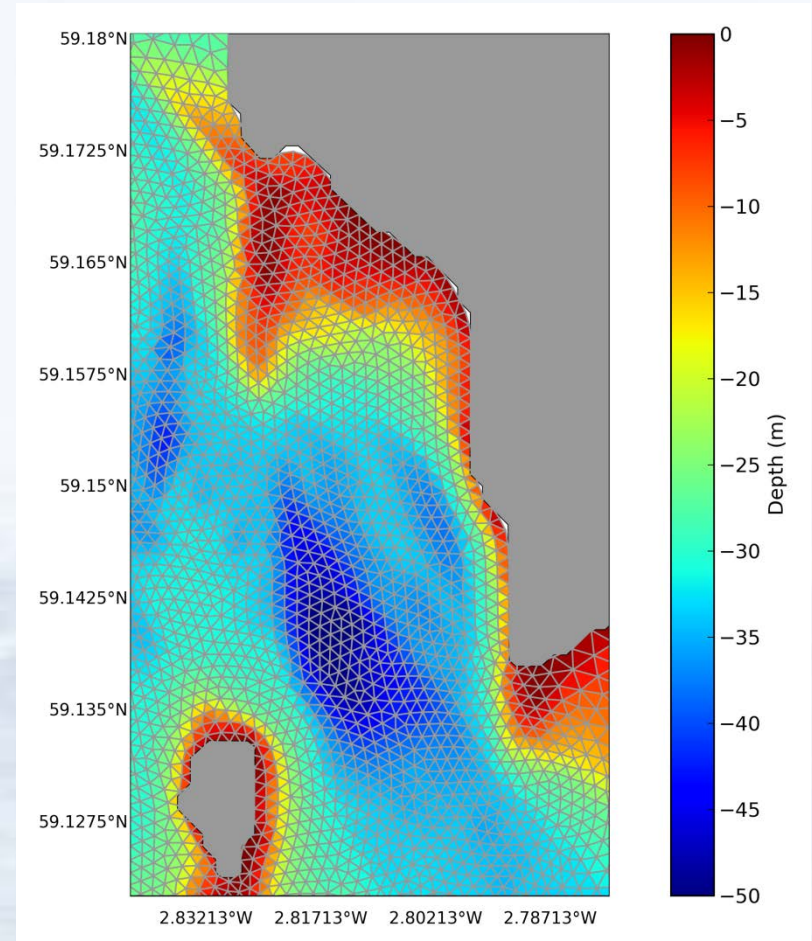
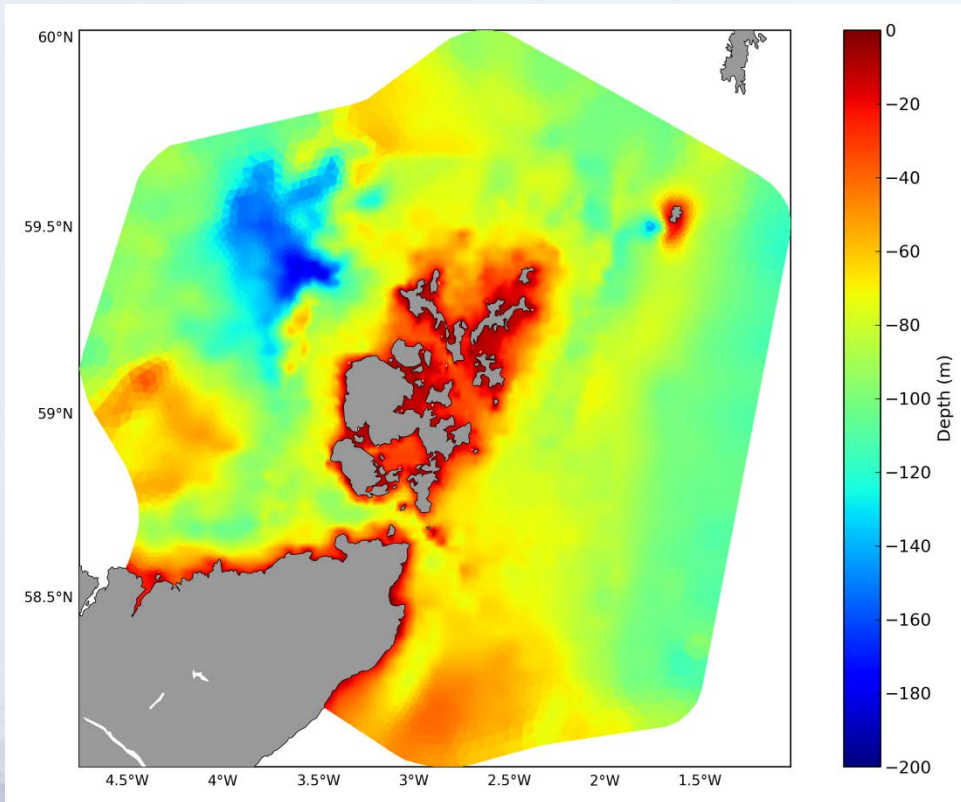
C: maintenance
vessel

D: OpenHydro Test
platform

Orca Tracks

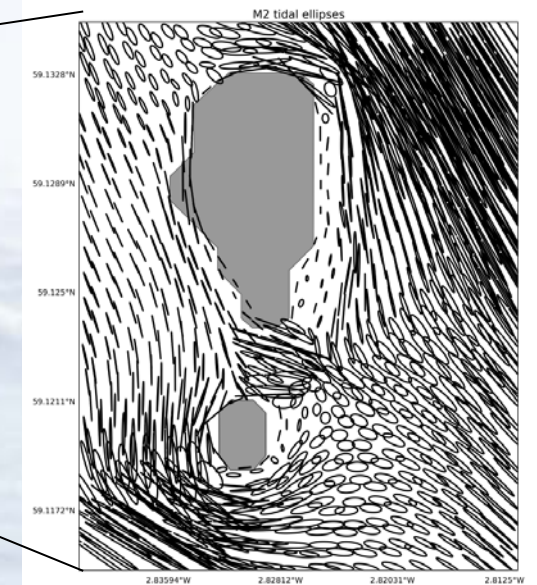
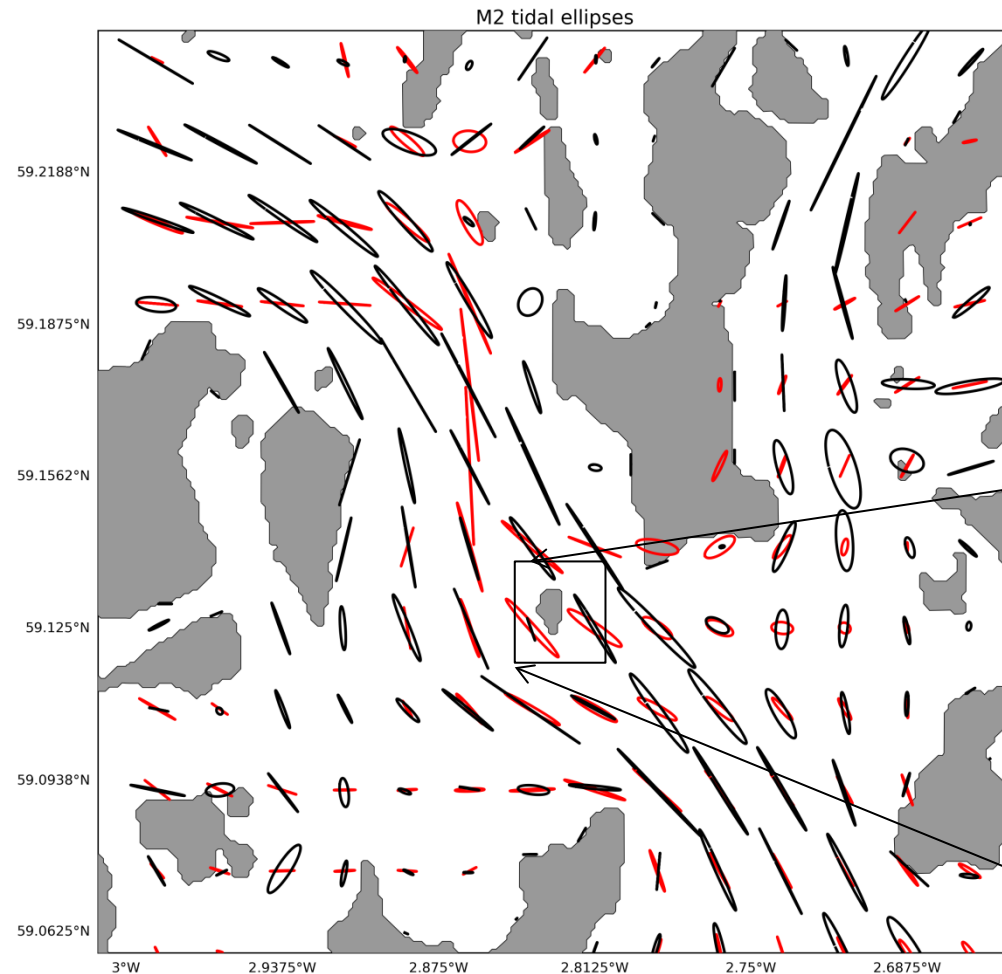
Bird Tracks

FVCOM modelling – Orkney area

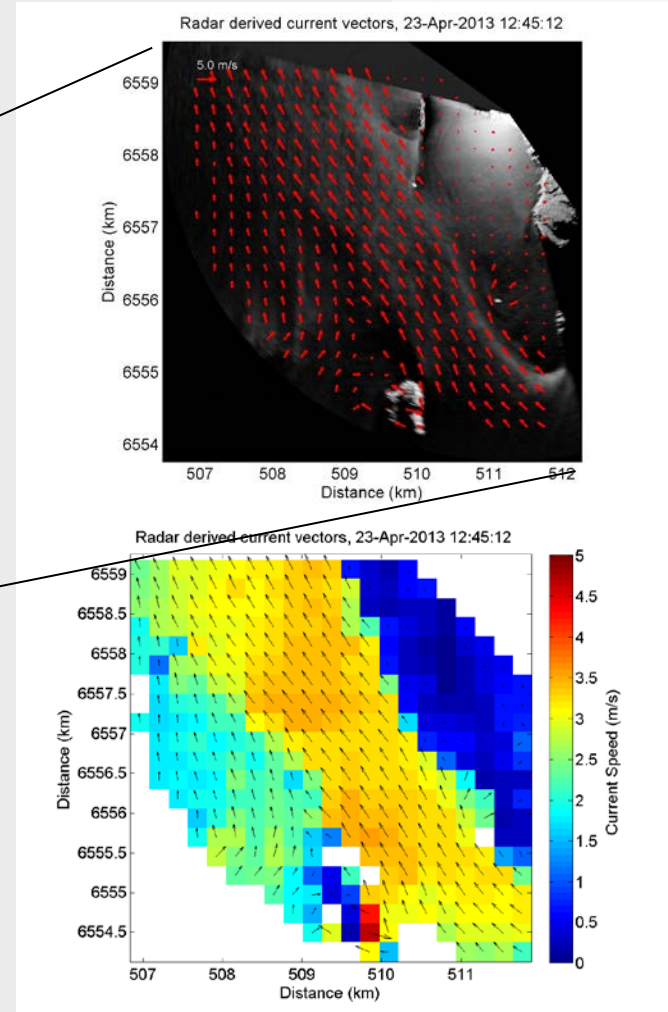
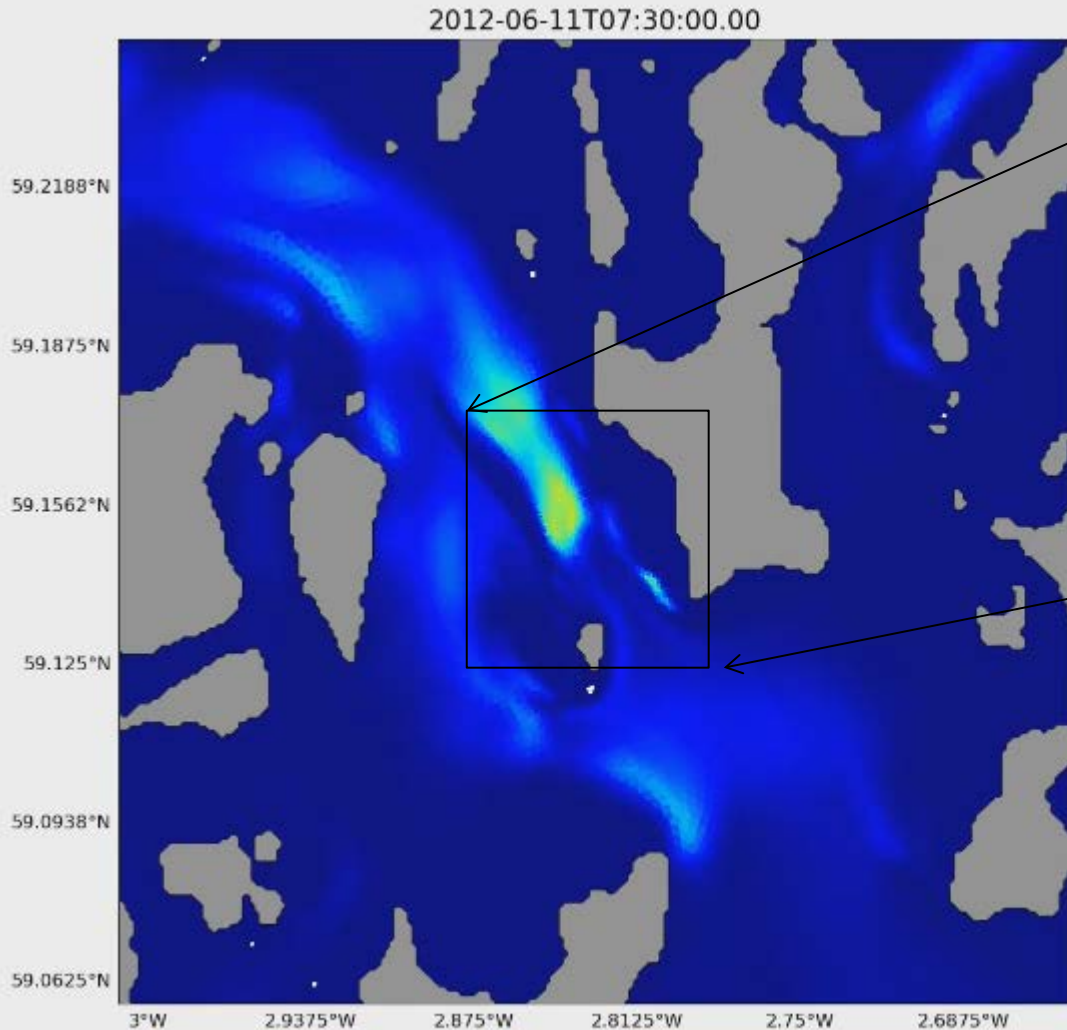


Images: Ricardo Torres & Pierre Cassenave, PML

FVCOM M2 Ellipses (ORKM POLPRED in red)



Investigating currents & turbulence



FVCOM – turbulence

Marine radar

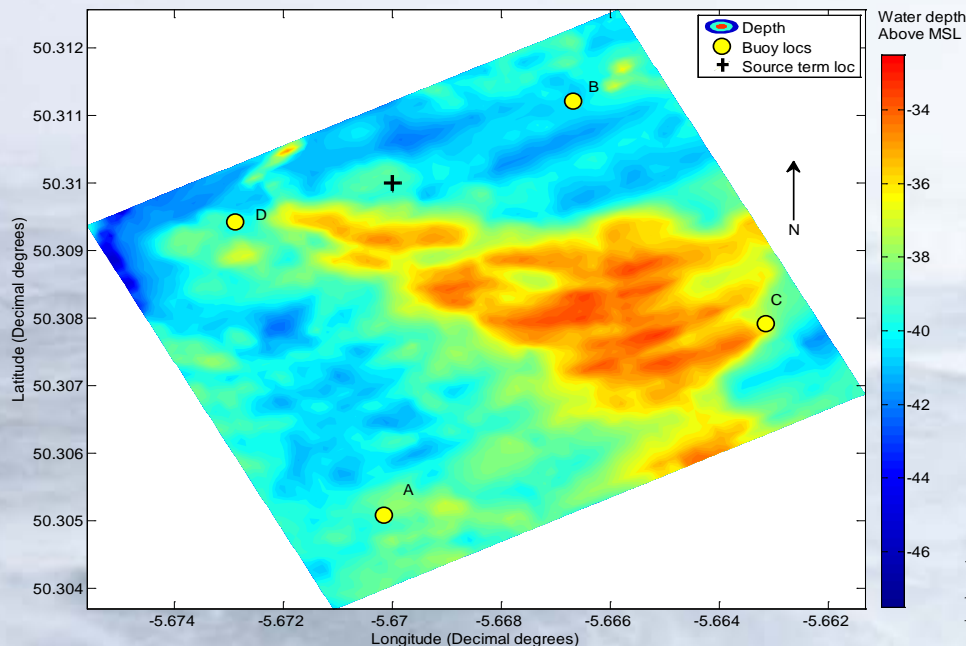
Wave Hub

- In situ wave and current measurements – focussed on understanding spatial variability
(Ian Ashton's Talk)
- HF Radar measurements of currents and wave height – spatial variability of wave height & currents
- FVCOM modelling of hydrodynamics – validation against various datasets

Arrays of wave measurements

High spatial variability in wave measurements from four wave buoys – not artefacts

~10% variation in wave power across 500m square area in open sea

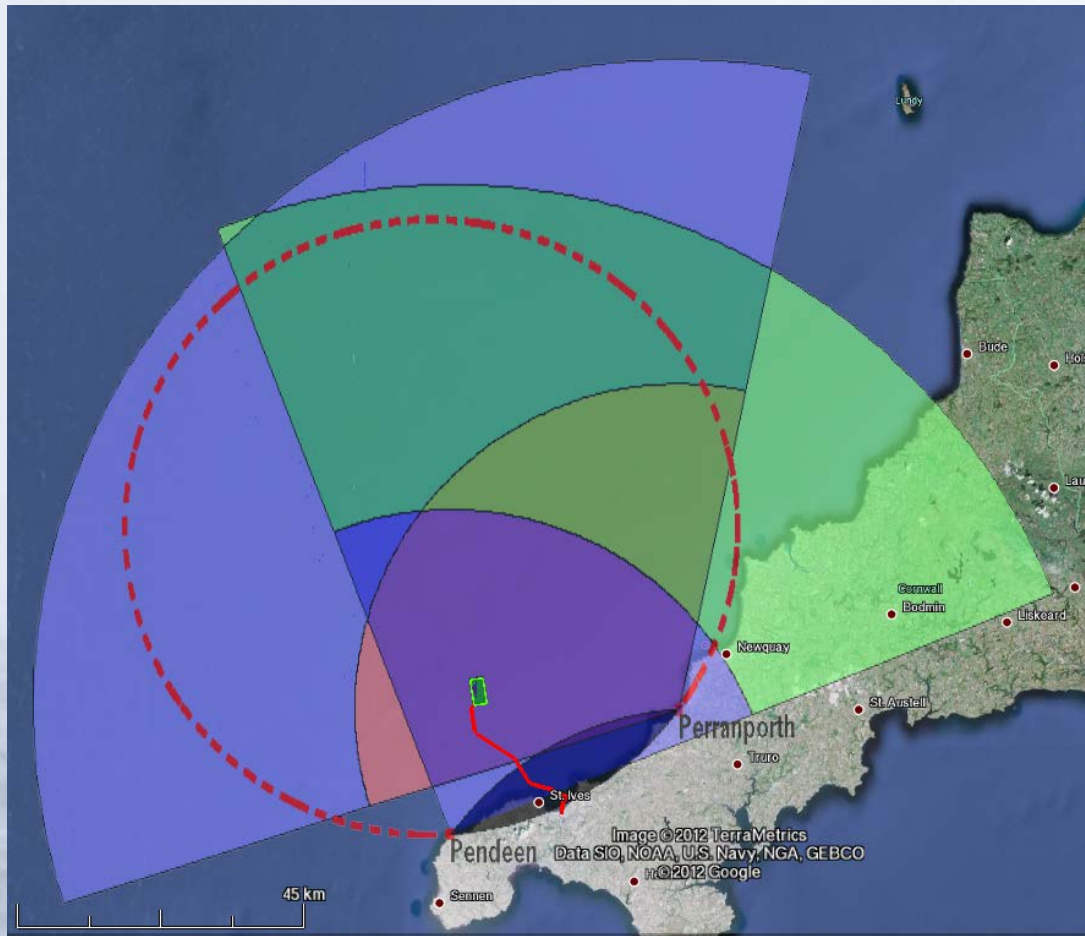


Wave buoy



Acoustic Doppler Current Profiler
picture from Ian Ashton – Exeter University

Wave Hub HF Radar Installation



- Work ongoing to improve empirical algorithms for wave height determination.
- Use of in-situ buoy measurements to develop a site specific correction.
- Progress in understanding the factors that can affect wave height measurements

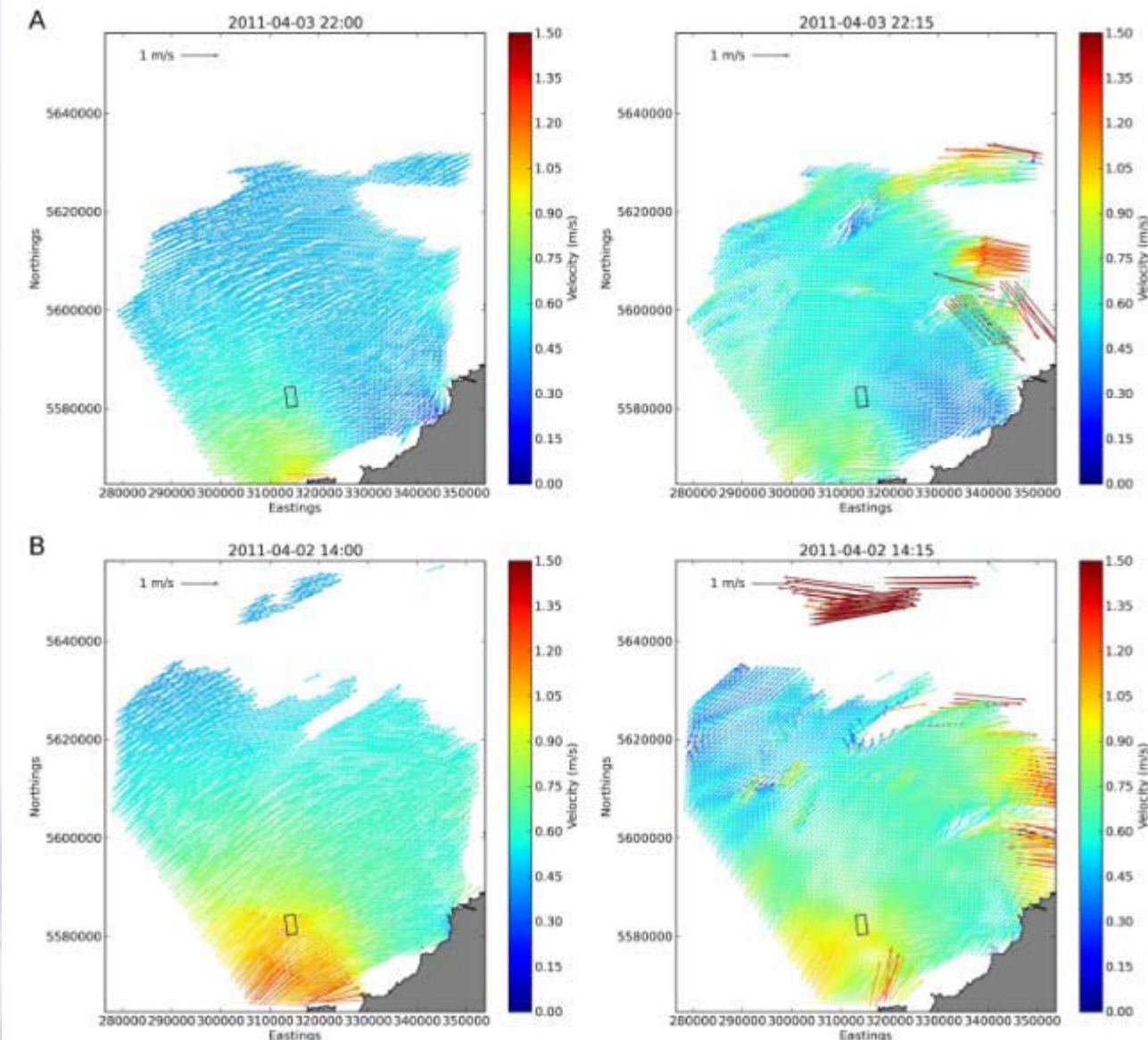
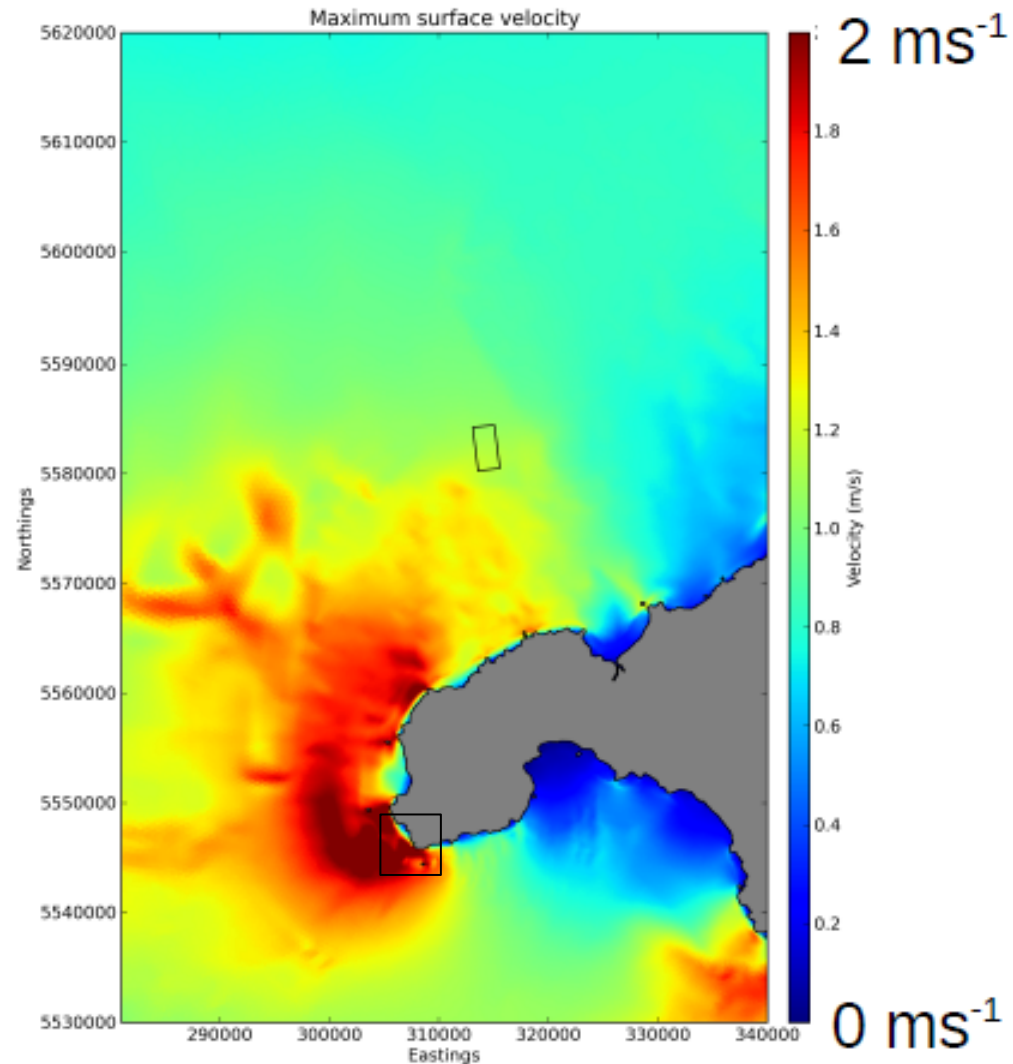
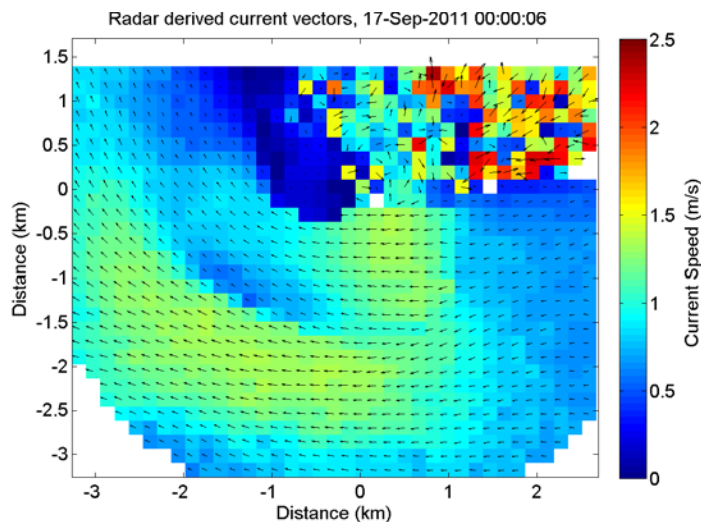
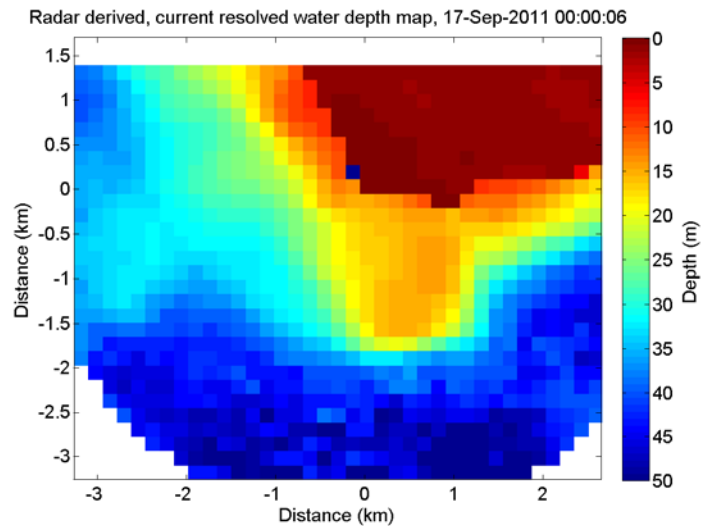


Figure 6. Comparison between two surface current snapshots of the Wave Hub region from the WERA HF radar (right) with FVCOM current predictions at the same times and locations (left). The colour scale indicates current speed, and the box represents the Wave Hub site.

Planned comparison of FVCOM currents with earlier radar data

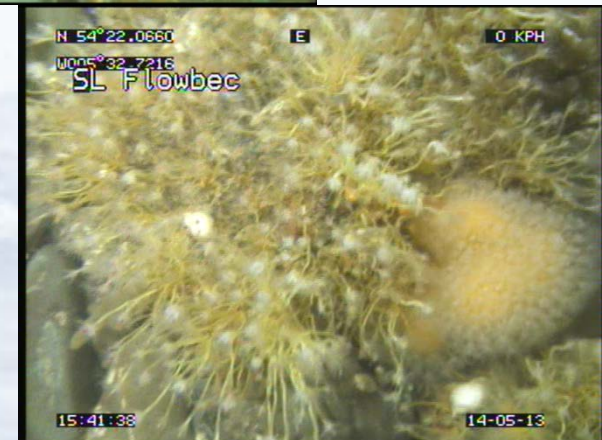
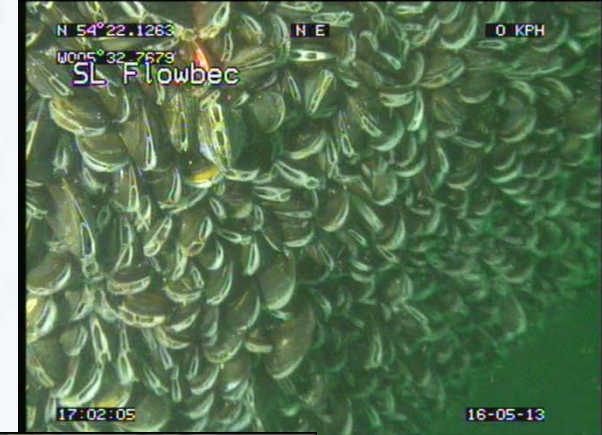
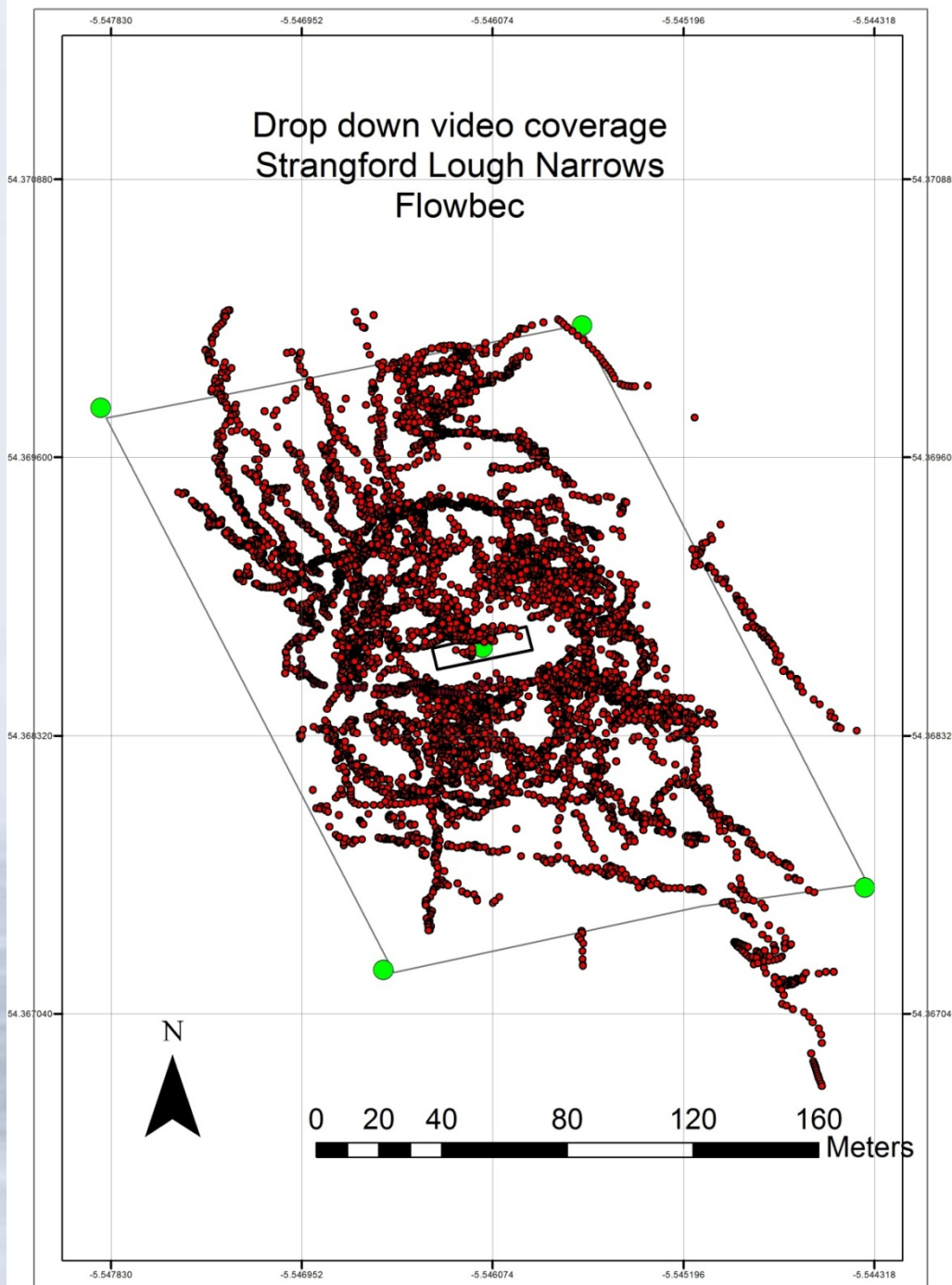
WaveHub surface currents



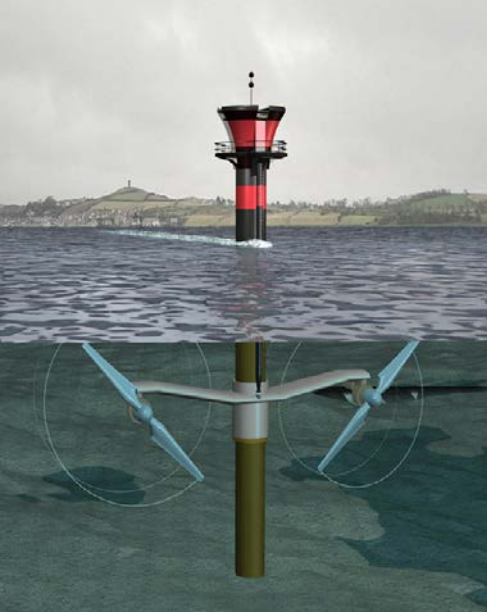
Strangford Lough

- **Drop down video surveys of benthic environment – see Jack O'Carroll's poster**
- **CFD modelling of turbine wake – Angus Creech, U. Edinburgh**
- **Investigate association between turbulent wake and spatial variability in benthos**





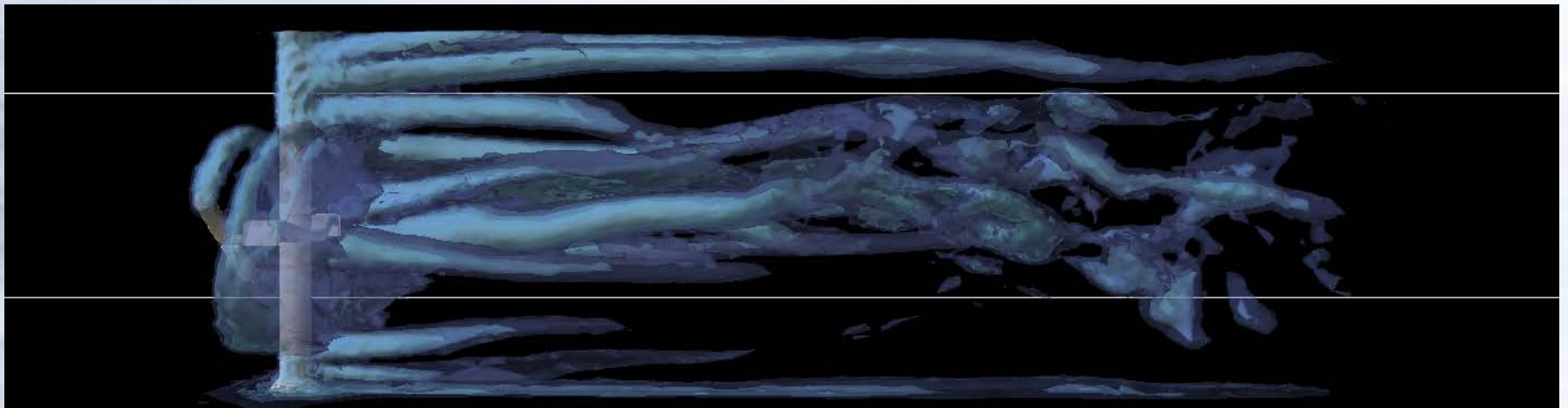
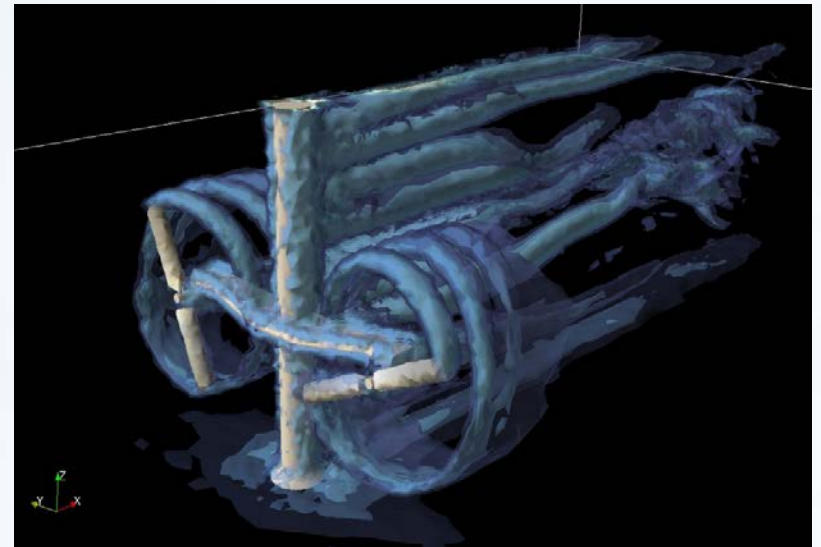
Images – Bob Kennedy & Jack O'Carroll



- Actuator line-modelled rotors and solid supporting structure
- Two contra-rotating rotors
- Based upon Seagen device operating in Strangford Lough
- Additional turbulence generated by structure

**Images by
Angus Creech
U. Edinburgh**

- Tip vortices and vortex sheets generated
- Also from tower / beam structure



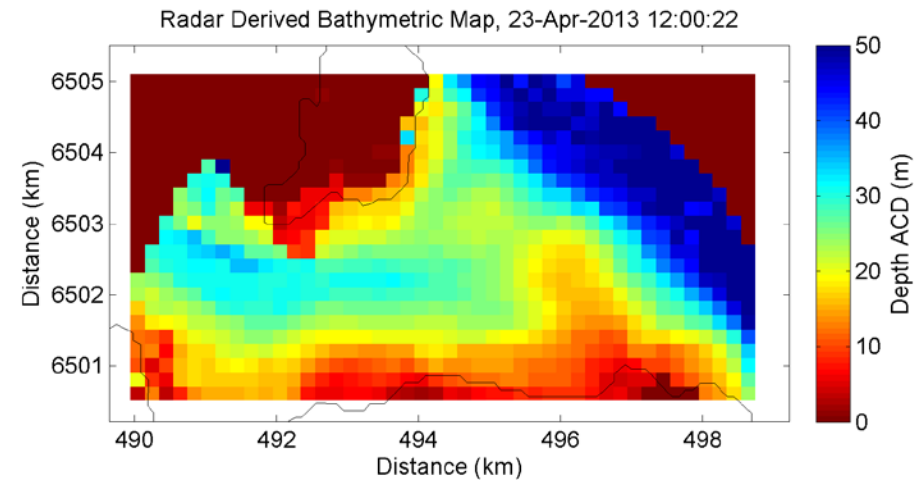
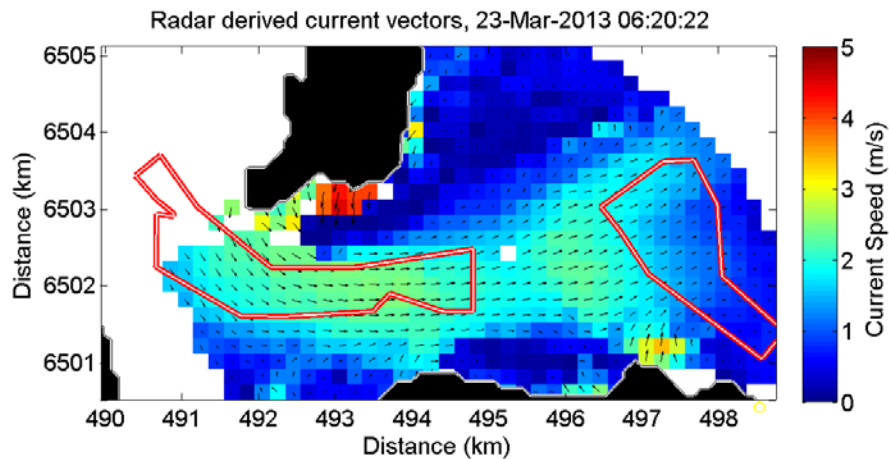
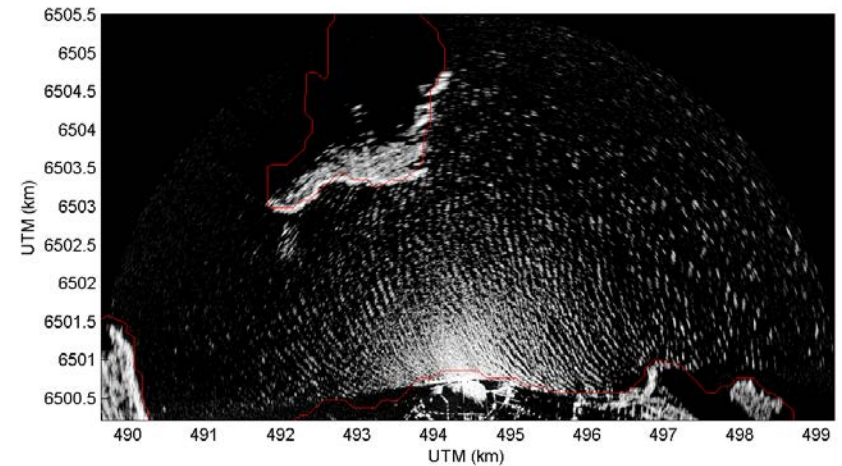
PentlandX – Radar deployments at Meygen site



Demonstration at Meygen Ltd
planned tidal turbine array site,
Inner Sound of Stroma in the
Pentland Firth



Paul Bell & David McCann,
NOC Liverpool



Acknowledgements

- **Funders:** NERC & DEFRA
- **Marine Scotland Science – Frame design & construction:** Chris Hall, Eric Armstrong, Paul Fernandes
- **EMEC:** The whole team at EMEC
- **OpenHydro, Atlantis Resources Corporation**
- **Imaginex, Hydro Products**
- **NOC:** Colin Bell, Applications Group (POLPRED) & Russell Wynn, MAREMAP Project
- Many many others!

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